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ship to a higher latitude than any ship has previously been—treading on the very heels of Parry—and an American has trod on more northern land), is England not to make an effort to hold her own? It is to be hoped that we shall soon see an expedition afoot—whether to Smith Sound or the Spitzbergen Strait it matters not, although, for the educational purpose alluded to, the latter is the best. Shame will be on us if a foreigner should step in and carry off our Polar honours; that even in this utilitarian age we shall find some men in power who do not consider it money thrown away to advance geographical knowledge and add to scientific research, and who will advocate the cause of Polar discovery and enable us to keep up our breed of Polar men, who add so much to the peaceful honours of our country.

That this great problem of the age may be solved, and that by Englishmen, is the heartfelt wish of every astronomer and geographer; and indeed every true Englishman would well be proud of a success which would redound so much to the honour of his country.

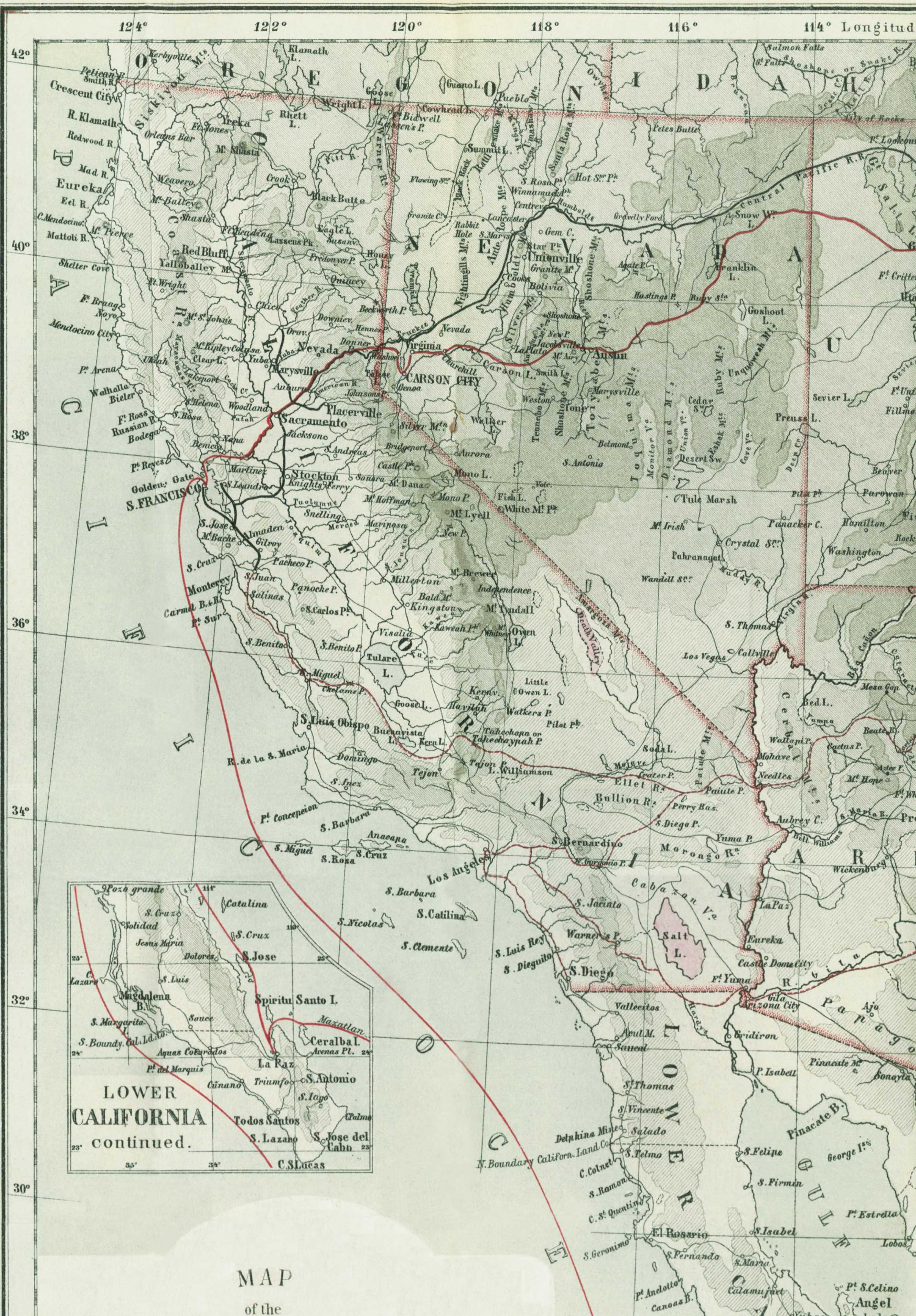
VI.—*On the Basin of Colorado and the Great Basin of North America.* By W. A. BELL, M.A., M.B.

Read, March 8, 1868.

IN the spring of 1867 a very extensive surveying expedition was organised by the Kansas Pacific Railway Company of North America, in order to determine upon the best route for a Southern Railway to the Pacific coast through Kansas, Colorado, New Mexico, Arizona, and the southern part of California.

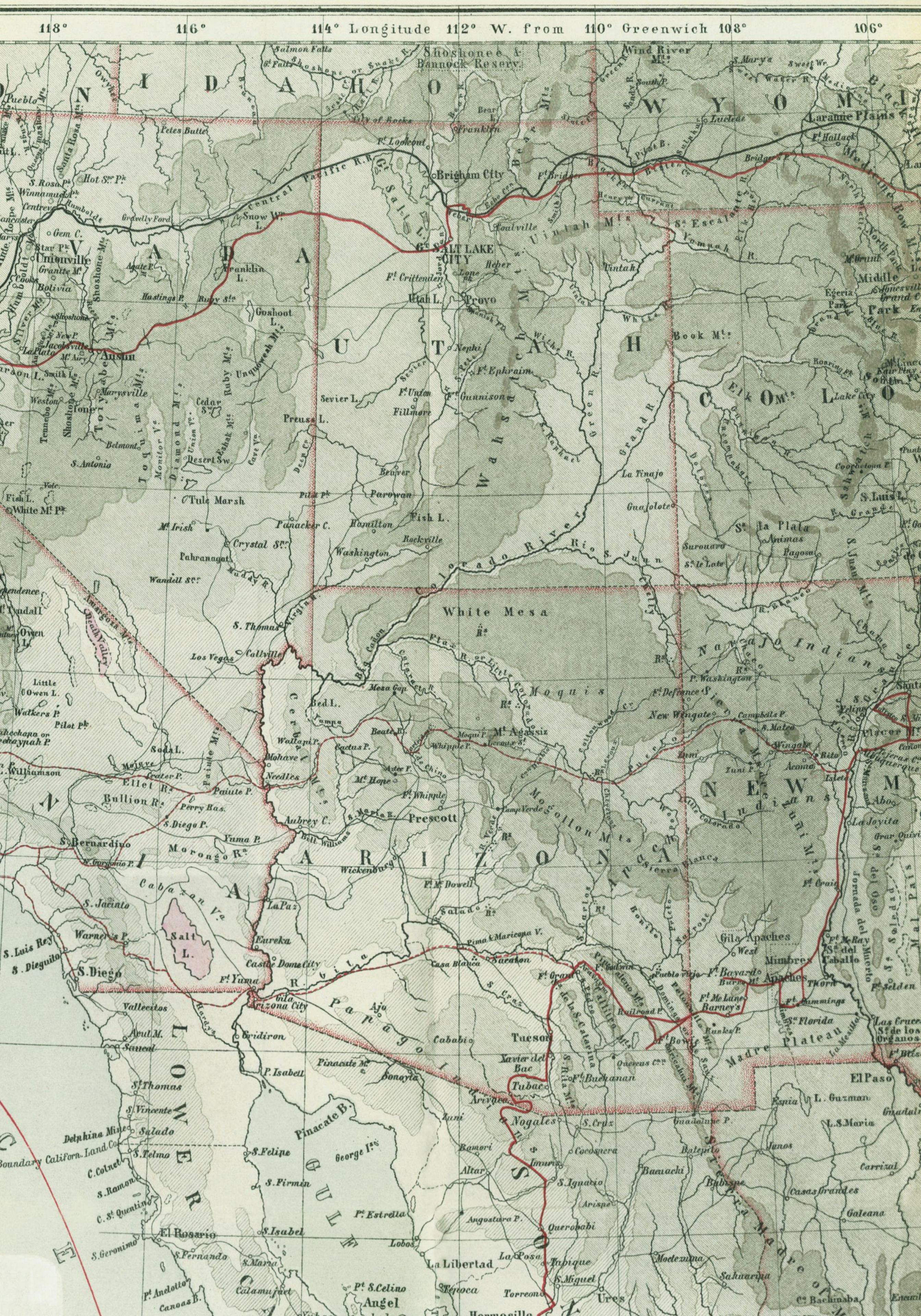
Until the Rio Grande (about equi-distant from the Mississippi and the Pacific) had been reached, three separate surveying parties only were required, but *west* of that river, across the regions of which the present paper treats, no less than five distinct parties, each capable of making an accurate instrumental survey for a railway, crossed the continent by different routes, on different parallels of latitude.

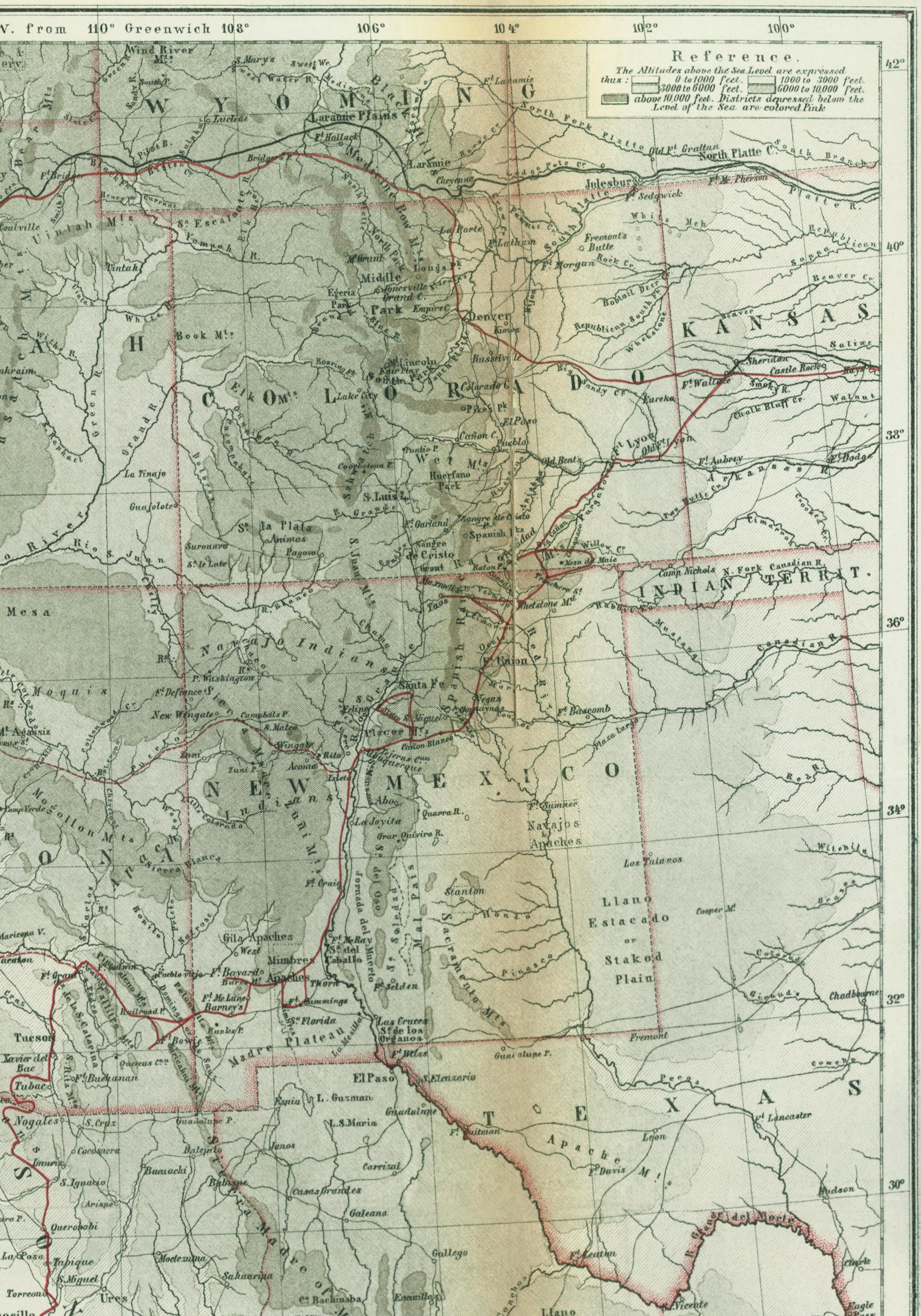
As my office in the expedition did not necessitate my taking any part in the surveys, or remaining permanently attached to any one party, I was enabled to travel over much of the country lying between the 33rd and 31st parallels of latitude in New Mexico and Arizona, and to recross the Great Basin and the Rio Colorado Basin, a second time about the 41st parallel. Others of our parties examined the country lying between the 34th and 35th parallels, and the information obtained from them,

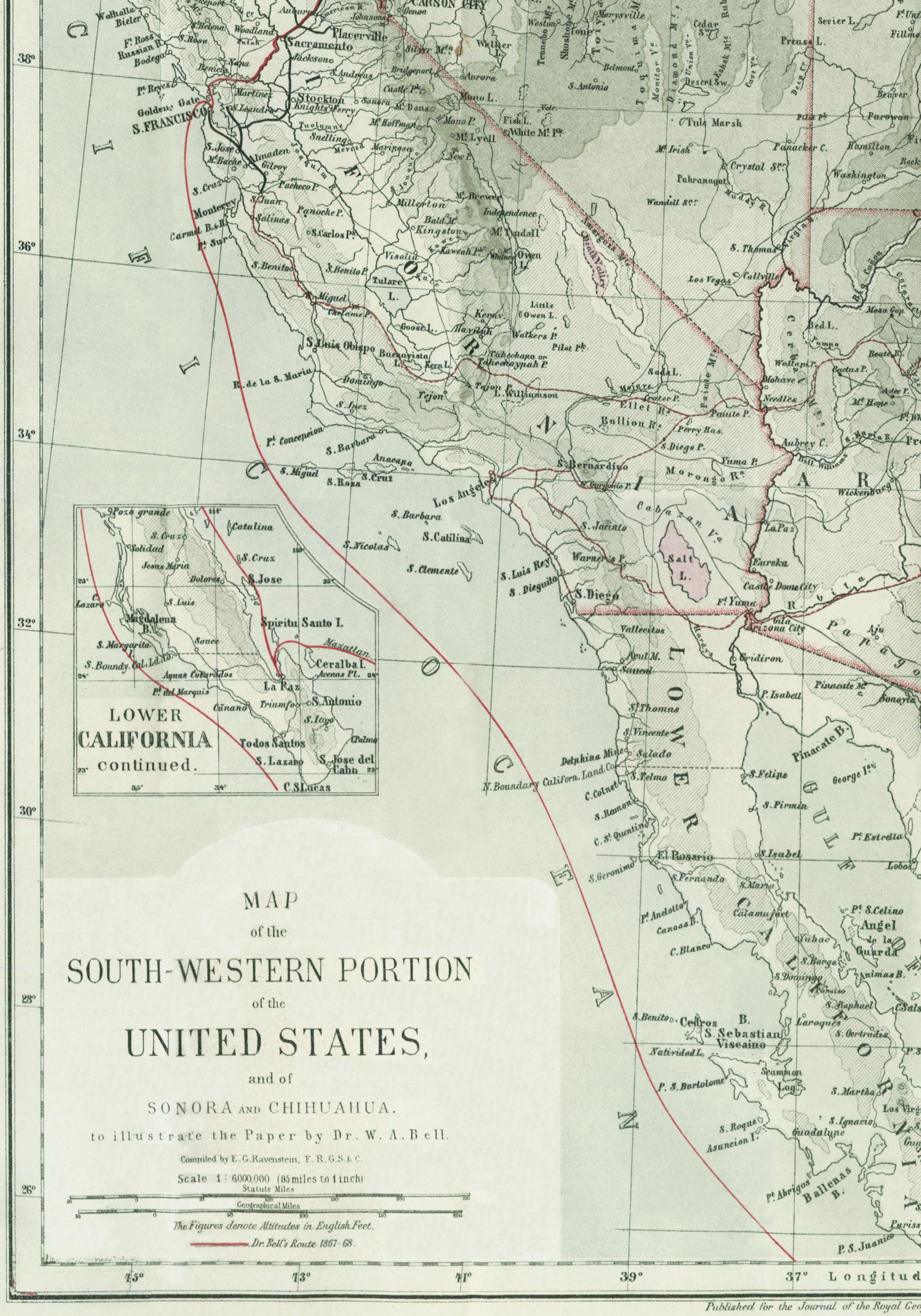

124°
122°
120°
118°
116°
114° Longitud
42°
40°
38°
36°
34°
32°
30°
OREGON
IDAHO
NEVADA
UTAH
CALIFORNIA
ARIZONA
LOWER CALIFORNIA
PACIFIC OCEAN
GULF
Crescent City
R. Klamath
Redwood R.
Mad R.
Eureka
Eel R.
C. Mendocino
Mattoli R.
Shelter Cove
Fᵗ Braag
Noyo
Mendocino City
Pᵗ Arena
Walhalla
Bieler
Fᵗ Ross
Russian R.
Bodega
Pᵗ Reyes
Golden Gate
S. FRANCISCO
Yreka
Mᵗ Shasta
Siskiyou Mᵗˢ
Orleans Bar
Weaverv.
Shasta
Red Bluff
Chico
Marysville
Nevada
Yuba
Auburn
Sacramento
Placerville
Stockton
Martinez
Benicia
Napa
S. Rosa
Ukiah
Clear L.
Woodland
S. Jose
Almaden
Gilroy
S. Cruz
Monterey
Salinas
S. Juan
Pᵗ Sur
Carmel B.
S. Benito
S. Miguel
S. Luis Obispo
R. de la S. Maria
Pᵗ Concepcion
S. Barbara
Anacapa
S. Rosa
S. Cruz
S. Miguel
Los Angeles
S. Catilina
S. Nicolas
S. Clemente
S. Luis Rey
S. Dieguito
S. Diego
S. Bernardino
S. Jacinto
Warner's P.
Salt L.
Cabazon Vᵃ
Fᵗ Yuma
Arizona City
Gila
La Paz
Eureka
Castle Dome City
Tulare L.
Visalia
Kern R.
Tejon
Tejon P.
Buenavista L.
Kern L.
Havilah
Walkers P.
Tehachapa or Tehechaypah P.
L. Williamson
Mojave
Soda L.
Bullion Rᵃ
Morongo Rᵃ
Yuma P.
Mᵗ Whitney
Owen L.
Mᵗ Tyndall
Independence
Kingston
Mᵗ Brewer
Millerton
Mariposa
Snelling
Mᵗ Lyell
Mono L.
Aurora
Bridgeport
Virginia
Carson City
Truckee
Tahoe L.
Genoa
Walker L.
Carson L.
Austin
Unionville
Humboldt
Central Pacific R.R.
Franklin L.
Goshoot L.
Ruby Mᵗˢ
Desert Sw.
Tule Marsh
Crystal Sp.
Pahranagat
Muddy R.
S. Thomas
Callville
Los Vegas
Amargosa Mᵗˢ
Death Valley
Mohave
Needles
Paiute P.
Ellet Rᵃ
Aubrey C.
Wickenburg
Parowan
Beaver
Preuss L.
Sevier L.
Washington
Pinacate B.
Vallecitos
S. Thomas
S. Vincente
Salado
Delphina Mine
S. Telmo
N. Boundary Californ. Land Co.
C. Colnet
S. Ramon
C. Sᵗ Quentin
El Rosario
S. Geronimo
S. Fernando
Pᵗ Anelotto
Canoas B.
Calamujuet
S. Felipe
S. Firmin
S. Isabel
Pᵗ Estrella
Pᵗ S. Celino
Angel
LOWER CALIFORNIA continued.
Poza grande
Catalina
S. Cruz
Solidad
Jesus Maria
Dolores
S. Jose
C. Lazaro
S. Luis
Magdalena B.
Spiritu Santo I.
S. Margarita I.
Sauce
Mazatlan
Ceralba I.
Arenas Pt.
Aguas Coloradas
Pᵗ del Marquis
La Paz
Cinano
Triumfo
S. Antonio
S. Iago
Todos Santos
S. Lazaro
S. Jose del Cabo
C. S. Lucas

MAP

of the


118°
116°
114° Longitude 112° W. from 110° Greenwich 108°
106°
IDAHO
WYOMING
NEVADA
UTAH
COLORADO
ARIZONA
NEW MEXICO
CALIFORNIA
LOWER CALIFORNIA
SONORA
GULF
Shoshonee & Bannock Reserv.
Salmon Falls
Shoshone or Snake R.
Wind River Mts
City of Rocks
Franklin
Bear L.
Pt. Lookout
Central Pacific R.R.
Brigham City
Gt. Salt L.
Gt. SALT LAKE CITY
Utah L.
Provo
Ft. Crittenden
Uintah Mts
Uintah
Coalville
Ft. Bridger
Laramie Plains
Ft. Halleck
Medicine Bow Mts
Lucleds
Bridgers P.
St. Mary's
Sweet Water R.
Green R.
Pueblo
Owyhee R.
Santa Rosa Mts
Petes Butte
Hot Sp. Pk.
S. Rosa Pk.
Winnamucca
Humboldt
Gravelly Ford
Snow Wr. L.
Franklin L.
Unionville
Star Pk.
Gem C.
Bolivia
Shoshone Mts
Hastings P.
Ruby Sts
Goshoot L.
Austin
Jacobsville
La Plata
Smith L.
Marysville
Ione
Toiyabe Mts
Toquima Mts
Monitor Va.
Diamond Mts
Ruby Mts
Unquowah Mts
Cedar Sp.
Belmont
S. Antonio
Desert Sw.
Tule Marsh
Fish L.
White Mt. Pk.
Mt. Irish
Crystal Sp.
Pahranagat
Wandell Sp.
Muddy R.
S. Thomas
Los Vegas
Callville
Amargosa Mts
Death Valley
Owen L.
Little Owen L.
Walkers P.
Pilot Pk.
Soda L.
Mojave
Crater P.
Ellet Rs.
Bullion Rs.
Paiute P.
Perry Bas.
S. Diego P.
Yuma P.
Morongo Rs.
S. Bernardino
S. Gorgonio P.
Cabazon Va.
S. Jacinto
Warner's P.
Salt L.
S. Luis Rey
S. Dieguito
S. Diego
Ft. Yuma
Vallecitos
Sauzal
St. Thomas
S. Vicente
Salado
S. Telmo
Delphina Mine
C. Colnet
S. Ramon
C. St. Quentin
El Rosario
S. Geronimo
S. Fernando
Pt. Anelotto
Canoas B.
Calamujuet
Boundary Californ. Land Co.
Nephi
Ft. Ephraim
Gunnison
Ft. Union
Fillmore
Sevier L.
Sevier
Preuss L.
Beaver
Parowan
Pilot Pk.
Panacker C.
Hamilton
Fish L.
Rockville
Washington
Wahsatch Mts
S. Raphael
Green R.
Grand R.
White R.
Book Mts
La Tinajo
Guajolote
Colorado River
Rio S. Juan
White Mesa
Big Cañon
Virgin
Flax R. or Little Colorado
Cataract R.
Meza Gap
Bed L.
Yampa
Beale P.
Moquis
Mt. Agassiz
Moqui P.
Whipple P.
Cactus P.
Aztec P.
Mt. Hope
Ft. Whipple
Prescott
Cerbat Mts
Mohave
Needles
Aubrey C.
Bill Williams
Wickenburg
Ft. McDowell
Camp Verde
Mogollon Mts
Apache
Sierra Blanca
Salado
Pima & Maricopa V.
Sacaton
Casa Blanca
La Paz
Eureka
Castle Dome City
Gila
R. Gila
Arizona City
Gridiron
Papago Indians
Aju
Cababi
Pinacate Mt.
Sonoyta
P. Isabel
Pinacate B.
George Is.
S. Felipe
S. Firmin
Pt. Estrella
S. Isabel
Lobos
La Libertad
Pt. S. Celino
Angel
Tepoca
Tucson
Xavier del Bac
Tubac
Arivaca
Nogales
S. Cruz
Ft. Buchanan
S. Rita Mts
Ft. Grant
Railroad P.
Ft. Bowie
Quercus Cn.
Ramori
Altar
Imuris
Cocospera
S. Ignacio
Angostura P.
Arispe
Babiacora
Tabique
Torreon
S. Miguel
Ures
Hermosillo
La Posa
Bacuachi
Moctezuma
Sahuarina
Batepito
Babispe
Sierra Madre
Navajo Indians
Ft. Defiance
P. Washington
New Wingate
Campbells P.
S. Mateo
Wingate
Zuni
Zuni P.
Zuni Mts
Acoma
Isleta
Rita
Placer Mts
Sante Fe
Albuquerque
Abo
La Joyita
Gran Quivira
Jornada del Muerto
Ft. Craig
Ft. McRay
Sn. del Caballo
Gila Apaches
Mimbres Apaches
Pueblo viejo
Ft. Bayard
Burro Mts
Ft. McLane
Barney's
Ft. Cummings
S. Florida
Madre Plateau
La Mesilla
Las Cruces
Sn. de los Organos
Ft. Bliss
El Paso
L. Guzman
L. S. Maria
Janos
Carrizal
Casas Grandes
Galeana
Cn. Bachiniba
Elk Mts
S. Luis
St. la Plata
Animas
Pagosa
Surouaro
St. le Loto
S. Juan Mts
Chama
Lake City
Middle Park
Egeria Park
Grand R.
Roaring Fork
Saguache
Cochetopa P.
Puebla
Escalante
Yampah R.
Elk Head R.
North Park
Mt. Grant
Fair Play
South Park
Rs.


W. from 110° Greenwich 108°
106°
104°
102°
100°
42°
40°
38°
36°
34°
32°
30°
Reference.
The Altitudes above the Sea Level are expressed thus:
0 to 1000 feet.
1000 to 3000 feet.
3000 to 6000 feet.
6000 to 10,000 feet.
above 10,000 feet. Districts depressed below the Level of the Sea are colored Pink
WYOMING
COLORADO
KANSAS
NEW MEXICO
INDIAN TERRIT.
TEXAS
Wind River Mts
S. Mary's
Sweet Wr.
Sweet Water R.
Black Hills
Ft Laramie
Laramie Plains
Ft Hallack
Medicine Bow Mts
Laramie
Cheyenne
North Fork Platte
Old Ft Grattan
North Platte C.
South Branch
Julesburg
Ft Sedgwick
Ft Mc Pherson
Platte R.
Lodge Pole Cr.
Bridger's P.
Ft Bridger
Uintah Mts
Coalville
Uintah
Sa Escalante
Yampah R.
La Porte
Ft Latham
South Platte
Fremont's Butte
Ft Morgan
White Mch
Republican
Rock Cr.
Bobtail Deer Cr.
Beaver Cr.
Mt Grant
Middle Park
Longs Pk
Jonesville
Grand C.
Egeria Park
Empire C.
Denver
Kiowa
Republican South Fk
Whetstone
Book Mts
Mt Lincoln
Fair Play
South Park
Russelville
Big Sandy Cr.
Saline
Sheridan
Castle Rock
Hays C.
Ft Wallace
Smoky R.
Chalk Bluff Cr.
Walnut
Eureka
Elk Mts
Lake City
Colorado C.
Pikes Pk
El Paso
Cañon C.
Pueblo
Ft Lyon
Old Ft Lyon
Ft Aubrey
Ft Dodge
Arkansas R.
Old Bents
Punto P.
Wet Mts
Huerfano Park
Coochetopa P.
Saguache
S. Luis
Two Butte Cr.
Crooked Cr.
Cimarron
La Tinajo
Guajolote
Grand R.
Green R.
S. Raphael
White R.
Sa La Plata
Animas
Pagosa
Ft Garland
Sangre de Cristo
Spanish Pks
Trinidad
Sangre de Cristo
Grant
Raton Mts
Raton P.
Mesa de Maie
Willow Cr.
Camp Nichols
N. Fork Canadian R.
Surouaro
Sa le Lote
Rio S. Juan
Colorado River
Mesa
Maxwell
Taos
Whetstone Md
Cimarron
Navajo Indians
Chama
S. Juan Mts
Spanish Range
Ft Union
Red R.
Mustang
Canadian R.
Moquis
Ft Defiance
P. Washington
New Wingate
Campbell's P.
S. Mateo
Mt Agassiz
Santa Fe
S. Miguel
Placer Mts
Vegas
Ft Bascomb
Wingate
Rita
Zuni
Acoma
Cañon Blanco
Albuquerque
Isleta
Plaza Largo
Mogollon Mts
Camp Verde
Little Colorado
Zuni Indians
Abo
Quarra R.
La Joyita
Gran Quivira R.
NEW MEXICO
Ft Sumner
Navajos Apaches
Red R.
Los Tulanos
Witchita
Sierra Blanca
Ft Craig
Jornada del Muerto
Sa del Oso
Sa Blanca
Sacramento Mts
Stanton
Hondo
Llano Estacado or Staked Plain
Cooper Mt
Brazos
Gila Apaches
West
Mimbres
Apaches
Mt McRay
Sa del Caballo
Pinasco
Colorado
Ft Grant
Pueblo viejo
Ft Bayard
Burro Mt
Thorn
Ft Selden
Ft McLane
Barney's
Railroad P.
Ft Cummings
Sa Florida
Las Cruces
Sa de los Organos
Tucson
Ft Bowie
Madre Plateau
Fremont
Ft Bliss
Guadalupe P.
Chadbourne
Xavier del Bac
Ft Buchanan
Tubac
Nogales
El Paso
S. Elenzario
Pecos
Guadalupe P.
L. Guzman
Guadalupe
L. S. Maria
Ft Quitman
Ft Lancaster
Leon
Apache Mts
Ft Davis
S. Cruz
Cocospera
Janos
Carrizal
Bavispe
Bacuachi
S. Ignatio
Casas Grandes
Galeana
Arispe
Querobabi
Moctezuma
Sierra Madre
Gallego
La Posa
Tabique
S. Miguel
Sahuarina
Ures
Torreon
Cs Bachinaba
Encinillas
Llano
Ft Leaton
R. Grande del Norte
S. Vicente
Eagle Pass
Clark
Hudson



LOWER
CALIFORNIA
continued.

MAP
of the
SOUTH-WESTERN PORTION
of the
UNITED STATES,
and of
SONORA AND CHIHUAHUA.

to illustrate the Paper by Dr. W. A. Bell.

Compiled by E. G. Ravenstein, F. R. G. S. & C.

Scale 1 : 6,000,000 (85 miles to 1 inch)

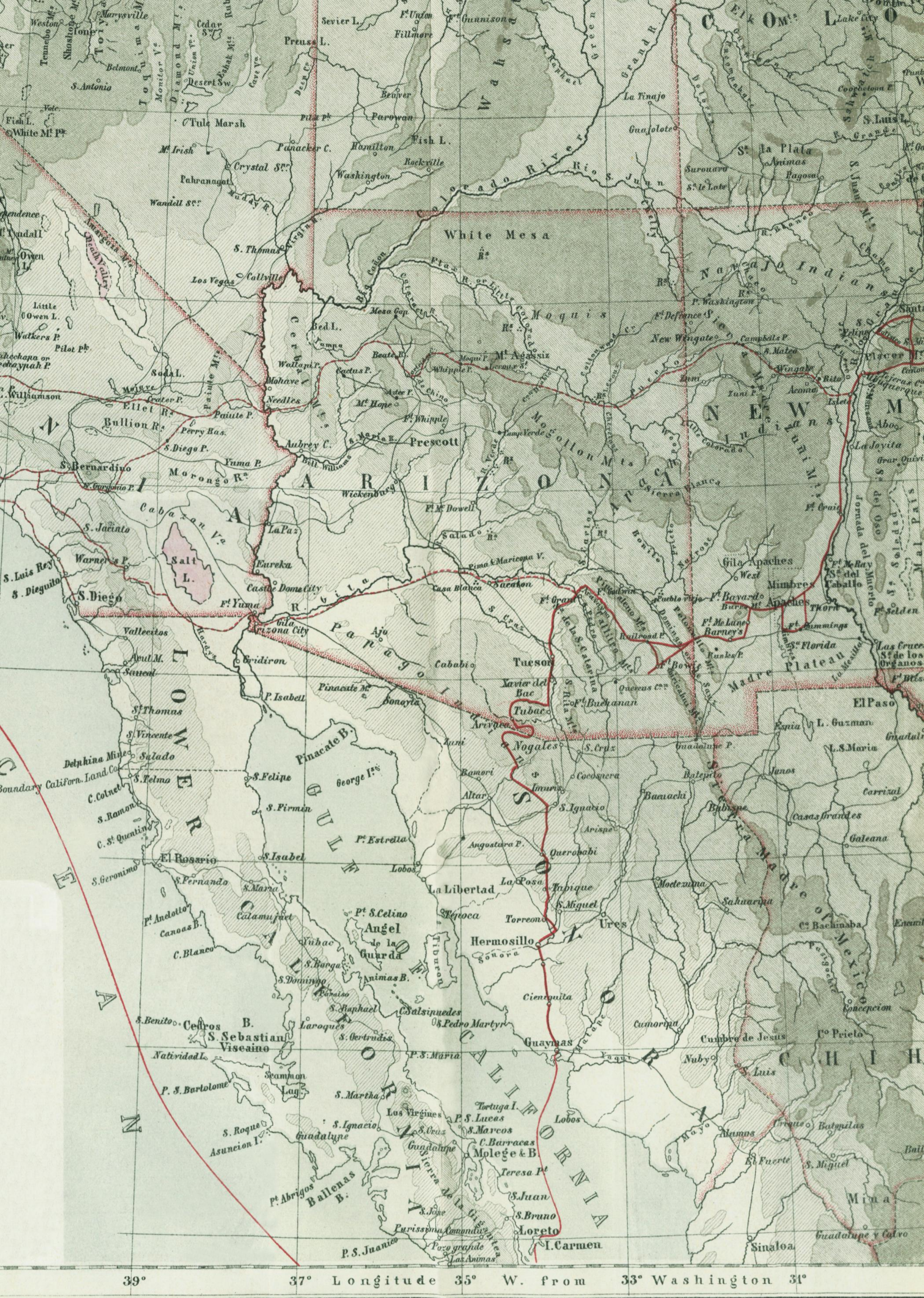
Statute Miles

Geographical Miles

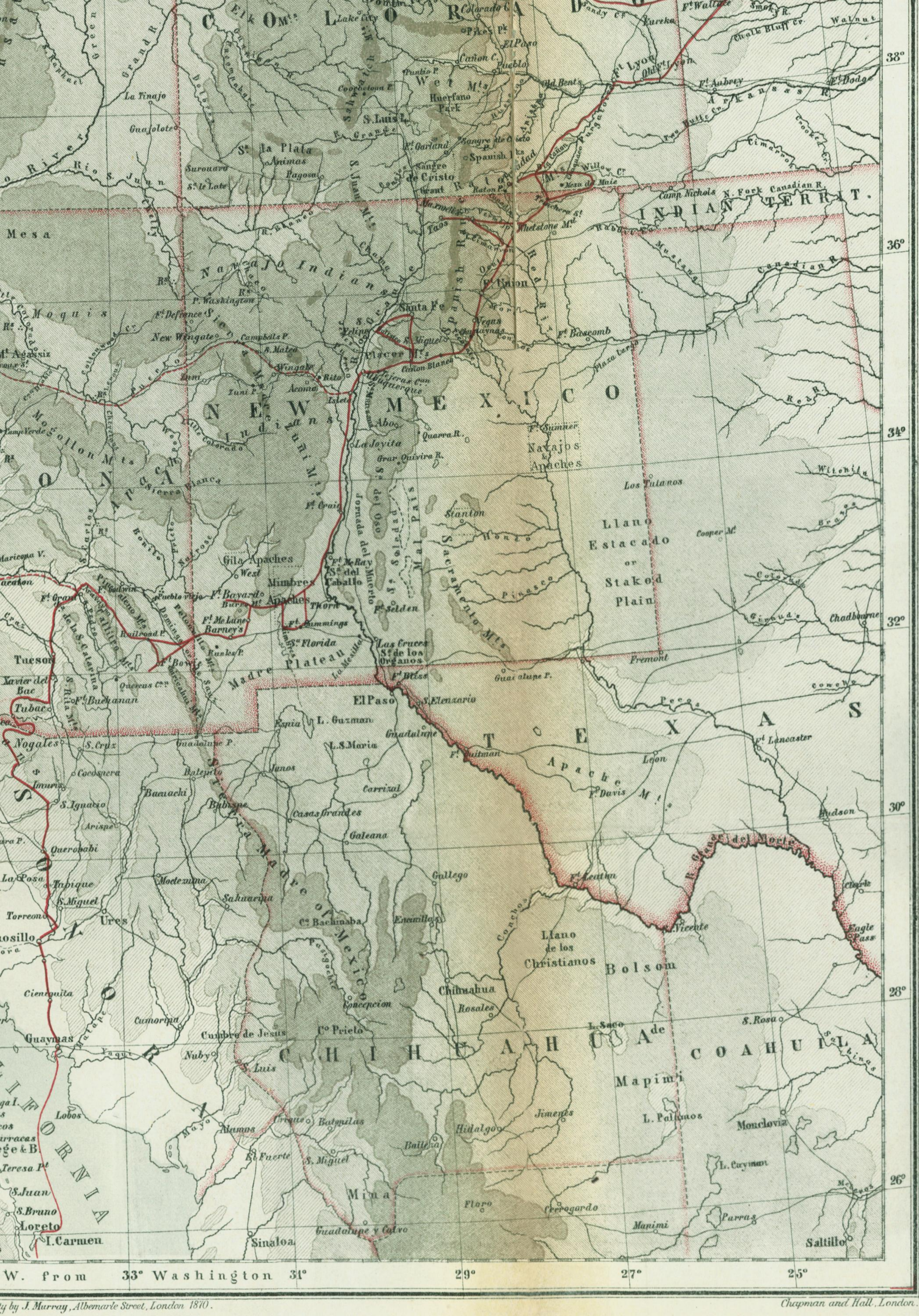
The Figures denote Altitudes in English Feet.

Dr. Bell's Route 1867-68.

Published for the Journal of the Royal Geo



Published for the Journal of the Royal Geographical Society by J. Murray, Albemarle Street, London 1870.



y by J. Murray, Albemarle Street, London 1870.

Chapman and Hall, London.

as well as that furnished by Lieutenant Ives, in his exploration of the navigable portion of the Rio Colorado, has been made use of, so as to give a sketch of the entire region.

That part of the territory of the United States which lies between the Rocky Mountains and the Sierra Nevada of California is composed of three river-basins:—

	Square Miles.
The basin of the Columbia River, which has an area of about	230,000
That of the Colorado	200,000
„ „ Great Basin	280,000

For the sake of comparison:—

The area of France is	210,000
That of the Mississippi River Basin	1,400,000
That of the Rio Grande del Norte Basin	210,000

As we did not enter the basin of the Columbia River whilst traversing the far west, I shall confine my observations exclusively to the other two sections of country, only remarking here that the "*divide*," which separates the Columbian basin from the great basin system passes from the southern extremity of the Blue Mountains of Oregon, in a south-westerly direction, into the Sierra Nevada system, about latitude 42°, and in a south-easterly direction almost to the great bend of Humboldt River; thence it passes a little northward again, as the ranges north of the basin indicate, between that river and the Snake, until it enters the northern extremity of the Wahsatch Mountains. From the northern extremity of these Wahsatch Mountains a short range, named the Bear Mountains, passes into the Rocky Mountains. This range separates the Columbia from the Colorado basin, and is the ridge by which this "divide" joins the main divide of the continent.

Between the main chains of the Rocky Mountains and the Sierra Nevada, the Wahsatch range is the largest and most important. It extends from the 41st degree of latitude, north of Great Salt Lake, almost to the 34th. For the first half of this distance its general direction is nearly south; for the latter south-west; so that it passes from the 111th to the 115th meridian. Throughout its entire length it forms the divide between the waters of the Colorado and the Great Basin.

About the head-waters of Bear River, one of the three tributaries of Great Salt Lake, this divide appears to require some slight explanation. Although Great Salt Lake is 4200 feet above the sea, and the Wahsatch Mountains rise in magnificent proportions to the east and north-east of it, yet this most western part of the range does not represent the rim of the basin—the dividing ridge between the waters of Salt Lake and of the Rio Colorado,—for the country behind is still higher, and the mountains themselves in this locality are some 70 miles across. The consequence is that the rim of the basin is found to lie some 60 miles east of the western slopes of the mountains.

he drainage of this mountain-belt of 60 miles in width collects in a central trough as Bear River. The river flows northwards in the trough amongst the mountains for about 300 miles, then bends westward around the western barriers, and flows southward into Great Salt Lake.

The central railway route (Union Pacific Railway) crosses the Wahsatch Mountains, passes around the northern end of the Great Lake, and then follows the valley of the Humboldt for 300 miles towards California. In approaching Salt Lake it is evident that the railway has to cross two main dividing ridges, 1st, the true rim of the basin, and 2ndly, the false rim, or the ridge lying between Bear River and the Lake. This ridge really consists of the lofty western range of the Wahsatch, and would have proved almost an insurmountable barrier, had not another tributary of the lake cut its way through it, forming Echo and Weber cañons.

The Colorado basin is separated from that of the Rio Grande and the Mississippi, on the east, by the continental divide or water parting of the Rocky Mountains, and from the watershed of the Laguna de Guzman, by an almost imperceptible divide, which crosses the level plateau of the Sierra Madre from the south-eastern extremity of the Burro Mountains to the mountains of Mexico. Thence the divide runs in a westerly course, sometimes in Mexican and sometimes in American territory, along the boundary line, separating the Gila branches of the Colorado from the streams of northern Sonora. We see, then, that the Colorado basin forms a large triangle, limited on the east by the dividing ridge of the continental watershed of the Rocky Mountains; on the south by the highlands about the Mexican boundary line; and on the north-west by the Wahsatch Mountains.

In the northern angle, almost reaching the 44th parallel, rise the waters of Green River. From the western slopes of the "summit plateau" of the Rocky Mountains further to the southward collect the heads of Grand River. These unite about 70 miles below the crossings of the old Spanish trail from Los Angelos to Abiquiu, about latitude 37° 30′, longitude 111°, and form the Rio Colorado of the West. The first tributary below the junction is the Rio San Juan coming from the east; then, about latitude 36° 15′, longitude 113° (Ives' Report), the next great tributary pours its waters into the Rio Colorado; this is the Flax River, or Colorado Chiquito (Little Colorado), and, lastly, the Rio Gila, which drains all the southern half of Arizona, enters the main stream at Fort Yuma, 60 miles above its mouth.

The entire Colorado basin consists of a series of table lands, rising one from the other and covering the whole country. In elevation they vary from 4000 to 7000 feet, and reach in some places a height of 8000 feet above the sea. They succeed each other in a series of steps, which generally present abrupt and wall-like edges, the more recent stratum occupying the highest portion of the plateau. Complete barrenness is the rule, fertility the rare exception; scarcely any vegetation, save the artemisia scrub, is to be found between the 36th and 42nd parallels; the earth for the most part is naked, showing the wear and tear of ages, the erosion of the primeval ocean, and the cracks and fissures of the more recent water-courses. Whence, we may ask, did the material come from, of which these table-lands are composed? In answer to this question I will quote Dr. Newberry, the geologist of Lieutenant Ives' expedition. "The question of the origin of the sediments composing the stratified rocks of the table-lands of the Colorado can scarcely be intelligently discussed, till we know more than we now do of the geology of a large area lying north of the Colorado, and of the broad and compound belt of mountains, which is covered by a single name —Rocky Mountains—but which, when carefully studied, will probably not be found to form a geological unity.

"This much, however, we can fairly infer, that the outlines of the North American continent were approximately marked out from the earliest Palæozoic times, not simply by areas of shallower waters in an almost boundless ocean but by groups of islands and broad continental surfaces of dry land. Since the erosion of rocks is always subaërial, or at least never takes place more than 40 feet below the ocean surface, it follows, that to form the stratified rocks of only that portion of the great central plateau which borders the Colorado, an island 300 miles in diameter and at least 6000 feet high—or, what is more probable, a continent of six times that area and 1000 feet high—was worn down by the action of waves and rains, and in the form of sediments, sand, gravel, clay, or lime, deposited on the sea-bottom."

These many thousand feet of sedimentary strata were converted into dry land by the gradual upheaval of the Plutonic rocks upon which they were deposited. Generally they were raised with but little disturbance of their original positions; still districts or rather lines of more powerful upheavals can be traced across the country, by the increased height of the table-lands, while here and there, more recent volcanic forces have thrust huge masses of igneous rock up through the sedimentary crust, forming mountains more or less isolated, and of great beauty, which contrast strangely with the eroded table-lands amongst which they rise. Such are the San Francisco mountains, Mount Taylor, and Bill Williams Mountain, all now extinct volcanoes.

The thousand springs of Green and Grand rivers which start from an elevation of from 10,000 to 12,000 feet, form cañons (that is to say, deep gorges) in the mountain districts only when some unusual obstacle bars their course. In the mountains which give them birth frequent rains have washed out sloping valleys, and the primitive rocks have generally succeeded in resisting to a great extent their erosive action. Further from their sources, beyond the influence of the mountain rains, these two rivers and their tributaries, in their passage over the table-lands of the great central plateau, have, by causes which we shall explain immediately, cut their way through them in channels, which deepen continually as they advance; and also, as they progress, present fewer and fewer open valleys to break the narrow and sunless perpendicularity of their gigantic walls; until, in the case of the Colorado, this penetrative tendency culminates in that mysterious gorge the Great Cañon of the Colorado, which until last year had never been traversed by any human being.

The Plateau of the Colorado, which is the name given to the district through which this river runs for 5 degrees of latitude, has been raised to an average elevation of 7000 feet. It extends in a north-westerly direction from a point south-east of the San Francisco Mountains, across the Colorado into Utah, and includes a portion of the country traversed by Grand and Green rivers, before they unite to form the Rio Colorado, as well as over a more considerable part of that crossed by the Colorado Chiquito along the latter part of its course.

"Over this plateau," says Dr. Newberry, "the Rio Colorado formerly flowed for at least 500 miles of its course, but in the lapse of ages, its rapid current has cut its bed down through all the sedimentary strata, and several hundred feet into the granite base on which they rest. For 300 miles the cut edges of the table-lands rise abruptly, often perpendicularly, from the water's edge, forming walls of from 3000 feet to over a mile in height. This is the Great Cañon of the Colorado, the most magnificent gorge, as well as the grandest geological section of which we have any knowledge."

We may, I think, conclude almost with certainty, that at some remote period during the present epoch, the lofty table-lands through which these rivers have cleft their way, had a much lower level than they have at present. Probably the

"Great Basin Region," lying to the westward, had not emerged from the Pacific ocean when these streams were wearing through the first hundred feet of the gorges which now enclose them. The upheaval of the table-lands was gradual; and was very unevenly distributed over all that vast plain—for it was originally a plain—lying between the Rocky Mountains and the Sierra Nevada. Wherever it happened that a perennial stream flowed over a plateau in process of upheaval, it wore its way deeper and deeper into the uprising strata, and as the rainfall was scant, the sides of the fissure thus formed retained their perpendicularity almost intact.

Since the winter of 1857-8, when Lieut. Ives and his party succeeded in examining the Cañon of the Colorado at two points in its course, no attempt has been made to throw any further light upon the structure or geography of this wondrous gorge. It chanced, however, that whilst our parties were surveying the valley of the Colorado Chiquito, an unfortunate prospector, named James White, was actually passing through the entire length of the chasm upon a simple raft of cottonwood.

A detailed account of this hazardous trip will be found in the first number of the 'Illustrated Travels,' and in my work on the Far West, 'New Tracks in North America.'

Between the Colorado plateau—through which the Little Colorado also cuts its way to join the main stream, like Grand and Green rivers, in a lofty side cañon of its own—and the Moquis country (another very elevated table-land), an elongated basin extends from the Mogollon Mountains north-west into Utah. As variegated marls here come to the surface, much of this wide trough has received the name of "The Painted Desert." Through a great part of this depression the Colorado Chiquito flows with open banks through fertile bottom-land of considerable extent till it reaches the Colorado plateau. To the north-east the country again rises step by step, mesa upon mesa; and upon the edges of several of these latter may be found those interesting fortified towns, the pueblos of the Moquis Indians.

When Lieut. Ives' party visited these regions, they tried to explore the country to the north-east, but want of water and extreme barrenness compelled them to return.

At the Moquis villages, the strata forming the table-lands begin to rise towards the east, and near Fort Defiance, where the Mesa country reaches an elevation of 8000 feet, they plainly show the disturbing influence of the most westerly axis of elevation of the Rocky Mountain system. Further east to the Rio Grande, and beyond it, they are much dislocated, and finally lose their distinctive character in the intricacies of the mountain ranges.

In the interval between Fort Defiance and the Rio Grande rises a great volcanic mountain, Mount Taylor (San Mateo), which, like that of San Francisco, has burst through the sedimentary strata and poured over them floods of lava, which are as fresh as though ejected but yesterday.

How, we may now ask, are cañons formed, and what are the physical conditions necessary for their formation?

Cañons are usually formed by the action of water only, unaided by volcanic action, which is often erroneously said to be the primary cause of the so-called fissures and cracks through which the waters flow. The physical conditions are, 1st, a dry climate, in which even periodical rains do not fall to any considerable amount; 2nd, the passage of never-failing streams from their distant and exterior sources through this dry country; 3rd, it is requisite that the surface strata should be of such a nature as easily to yield to the action of the current; but when once a groove has been furrowed and the water-channel definitely fixed, it does not appear to matter of what the underlying rocks are composed, since the unceasing attrition of ages has in some instances succeeded in cutting through hundreds of feet of the hardest granite; 4th, it is requisite that the slope of the land should be sufficiently great to ensure a rapid current.

It is impossible for a country in which cañons abound to be anything but sterile and utterly worthless, for the deep cuttings everywhere drain it to the utmost, and the waters, buried deep in the bowels of the earth, lie far beyond the reach of animal or vegetable life on the surface.

Before leaving these regions, one other question is worthy of our consideration, viz., To what causes are due the mesa or table-lands, features of this country? In the solution of this problem Dr. Newberry says as follows:—

"Like the great cañons of the Colorado, the broad valleys bounded by high perpendicular walls belong to a vast system of erosion, and are wholly due to the action of water. Probably nowhere in the world has the action of this agent produced results so surprising, both as regards their magnitude and their peculiar character. It is not at all strange that a cause which has given to what was once an immense plain, underlayed by thousands of feet of sedimentary rocks conformable throughout, a topographical character more complicated than that of any mountain chain, which has made much of it absolutely impassable to man or any animal but the winged orders of creation, should be regarded as something out of the common course of nature. Hence the first and most plausible explanation of the striking surface features of this region is to refer them to that embodiment of resistless power—the sword which cuts so many geological knots—volcanic force.

"The great cañon of the Colorado would be considered a vast fissure or rent in the earth's crust, and the abrupt termination of the steppes of the table-lands as marking lines of displacement. This theory, though so plausible and so entirely adequate to explain all the striking phenomena, lacks a single requisite to acceptance, and that is *truth.* Aside from the slight local disturbance of the sedimentary rocks about the San Francisco Mountain, from the spurs of the Rocky Mountains, near Fort Defiance, to those of the Cerbal and Aztec mountains on the west, the strata of the table-lands are as entirely unbroken as when deposited. Having this question constantly in mind, and examining with all possible care the structure of the cañons which we entered, I everywhere found evidence of the exclusive action of waters in their formation. The opposite sides of the deepest chasm showed perfect correspondence of stratification conforming to the general dip, and nowhere was there displacement; the bottom rock, often dry and bare, was perhaps deeply eroded, but continuous from side to side, a portion of the yet undivided series lying below. The mesa walls should be included in the same category with those of the cañons: sometimes, indeed, they are but the sides of cañons miles in breadth."

Leaving the weird and worthless regions north of the 36th parallel, let us glance for a moment at those forming Central Arizona, and lying between the Colorado Chiquito and the Rio Gila. Nearly all the region has been greatly disturbed by innumerable ranges of mountains more or less volcanic, while the surface is covered with the products of volcanoes now extinct, and with the drift washed from the mountain sides.

Between the head-waters of the Rio Gila and the Colorado Chiquito is a very high tract of country which is chiefly occupied by the various ranges known as the Mogollon Mountains; and which shed their waters in a southern direction to form the Rio Gila, and in a north and north-western direction towards the Colorado Chiquito. But the hostile Indians of these regions have, up to the present time, so kept the white man at bay that no explorations have been made through them, and we know nothing of the country except from the few daring prospectors whom thirst for gold has led to risk their lives in its pursuit. The reports of these men, who are wonderfully shrewd and reliable, describe the land as being very beautiful and of great fertility. Forests of noble pine cover large portions of the mountains, enclosing well-watered "parks" and valleys of considerable extent, clothed with luxuriant Grama grass; and although much of it is wild and barren, cut up by ravines and impassable barriers, still the signs of mineral wealth everywhere abound, and predict a prosperous future for this country.

The moisture from the Gulf of Mexico has no great obstacle to bar its way between the Texan coast and these regions, and to cause its precipitation before arriving at them; for the "summit-plateau" in this latitude has sloped away, and the Rocky Mountain chains have ceased to be conspicuous, so that the rainfall about the mountains of Central Arizona is far greater than the travellers who have passed north, or, as is more usually the case, south of them in the more level though more arid districts, are aware of.

The next belt of mountains, or line of upheaval, also trending north-west and south-east, is that important Cordillera which has the Aztec Mountains, Bill Williams Mountain, and perhaps the San Francisco peaks, to mark its northern extremity. It passes obliquely across Arizona, cresting the San Francisco plateau; forming the Pina-leño Mountains, north and south of the Rio Gila; the Chiricahui Mountains, their continuation; the Sierra Calitro and Sierra de Santa Cantarena, which are parallel ranges; then, crossing the boundary line into Mexico, the mountain sources of the San Pedro and Santa Cruz rivers form part of the same belt of upheaval. At last it is merged into the Sierra Madre ranges, which cap the plateau of Mexico. If the Sierra Madre, or main mountain chain of Mexico Proper, be a continuation of any northerly chain, it is of that which I have just mentioned, and not, as is commonly but erroneously supposed, of the Rocky Mountains, which undoubtedly lose themselves at least two degrees to the north-east in the broad plateau of New Mexico, known as the Plateau of the Sierra Madre.

When a range of mountains forms the main continental water-parting, the Mexicans of the locality very commonly call it the "Sierra Madre," or mother mountain: thus it happens that there are several Sierra Madres, which belong not only to the actual Rocky Mountain system north of the 34th parallel, but also rise from the highest plateau of Mexico proper. And while referring to this distinction, I may add that I, for my part, should like to carry the same idea further, and leave out the word "Sierra" in the name given to the great plateau of Southern New Mexico, thus calling it simply the Madre, or Mother Plateau, because the continental divide actually crosses it, although no range of mountains, or in fact any perceptible inequality of surface, marks the water-parting.

North of the Rio Gila the description of the Mogollon mountain belt applies with equal truth to these ranges, except that portions of the country amongst the latter have been settled partly by Mexicans, the remnant of the Spanish occupation of the 16th and 17th centuries, and partly by Americans since the annexation in 1848. Extensive mining districts have been discovered, mines have been opened, and found to yield abundantly; herdsmen have commenced raising stock, and farmers have found that crops could be grown, even without irrigation, in many places around Prescott (the capital) situated in the northern part of this belt of mountains. But the wild Indians of these regions are waging, as they have been waging for ages, unceasing war against the cultivator of the soil, whether he be Aztec, Mexican, or Anglo-Saxon; and although vastly inferior beings in every respect, these savages are even now successfully stamping out the efforts of the white men to inhabit the country. The Apaches, who have ever lived by the plunder of their neighbours, are at this moment successfully driving back the tide of emigration in central and southern Arizona, and neither the settlers nor the military dispersed throughout the country are able to contend successfully against them.

Wherever we or our parties have been, we have found the whole country strewn with the ruins of villages, irrigating canals and pottery, belonging to a populous race now extinct. The Indians of the Moquis villages, which have been referred to, those of the Pimo villages, who cultivate large tracts of land in the Rio Gila bottoms, and the wandering tribe—the Papagos—who inhabit a large tract of country, almost a desert, south of that river, are the only civilized Indians now to be found in Arizona. The fertile valleys of these regions once supported a very considerable population. Have the Apaches overpowered them, or have recent physical changes in the country led to their disappearance? There is much to be said in favour of either hypothesis; but as this subject is not a geographical one, I shall not occupy the meeting in discussing it.

Between the comparatively fertile belt of mountainous country which we have been considering and the Rio Colorado, lies a district less elevated, and becoming very dry and arid as we pass westward. It is, however, covered more or less with short ranges of bare volcanic hills which are rich in minerals, gold and silver veins, and which are attracting the attention of miners from California more and more every year. At last the Colorado desert itself is reached. The river having traversed the lofty plateau in almost a due westerly course, takes a great bend to the south, and emerging from its cañoned table-lands into the lower country, meanders through broad and sultry valleys below Fort Yuma, which become more and more parched and sterile as they near the head of the Gulf of California.

The Rio Gila does much the same thing; it cuts through the Pina-liño Mountains, north of Camp Grant, by means of a succession of cañons. Its *bottom*-lands are extensive and fertile *above* these cañons for a distance, which at present is not ascertained, and *below* them for about 50 miles in the Pimo country. But further west it enters the sterile country known as the Gila desert, the continuation northward of the great Sonora desert, and passes through it for the remaining 150 miles of its course, until it reaches the Colorado. This completes our rapid survey of the Colorado basin. We will presently cross the Wahsatch mountains forming part of its western boundary, and take a bird's-eye view of the Great Basin beyond.

Passage of the Aravaypa Cañon.—Whilst surveying and exploring for a route through the Pina-leño Cordillera, a little south of the Rio Gila, I passed through a cañon of great interest, formed by a tributary of the Rio San Pedro—the Aravaypa—which little stream cuts through the centre one of the three ranges forming that extensive cordillera. As this cañon is a good type of its class, I think that a detailed description of it may not be an uninteresting ending to this sketch of the Colorado Basin.

We had, of course, to dispense with waggons, and, whilst we were cutting our way through 30 miles of gorge to Camp Grant from the head of the cañon, they had to be sent round by a southern route, 180 miles, to the same military post.

Descending from Railroad Pass, a gap between the Pena-leño and Chiricahui mountains, we entered a trough between these two almost continuous ranges, and the Sierra Calitro parallel to them. We followed this trough in a N.W. direction for 22 miles before we entered the basin of the Aravaypa, and rose during that distance 280 feet. Soon a deep groove appeared at the bottom of the trough, which, as we travelled down it, became deeper and deeper, until its sides assumed the appearance of cliffs. A few miles further, a dry watercourse appeared; then a spring, causing great fertility, while back beyond the cliffs rose the serrated summits of the volcanic ranges on either side. These ranges gradually approach each other, until the trough itself becomes obliterated, and the walls of the groove in its centre were of necessity merged into the mountain sides. At the point where the mountains seem to unite, the Cañon proper begins. This point is 25½ miles from the first appearance of a central groove in the trough, and during this distance we descended 1104 ft.

We remained a few days, at the entrance, to arrange the packs for the mules we intended to take with us, and to obtain, if possible, a few more soldiers from a military post 50 miles distant; for the Aravaypa Cañon was the home of the Apache, and a place where it was considered almost madness to venture under any circumstances. Six days and five nights were spent in cutting our way through this wonderful defile, and, though the remembrance of it cannot but be a vivid one, I feel that it is quite impossible to give anything like a fair description of it.

Guarding the narrow entrance rises a conical hill, to which we gave the name of "Look-out Mountain," for it commands a very extensive view both into the Cañon and up the Cañada in the opposite direction; furthermore, it is most probable that when this country was inhabited it was used for that purpose, for the stone foundations of a building which formerly covered the summit are still distinctly visible. Close under this hill a very large stream gushes out of the ground, the waters of which more than double in size the Aravaypa stream. Without this large permanent supply of running water, the Aravaypa Cañon could (probably) never have been formed. In the first two miles the walls are perpendicular on one side and sloping on the other; the former do not exceed 500 feet in height, but at the end of that distance a large triangular mass juts up from the centre of the ravine, which seemed to us to bar all further progress. The stream, however, had managed to turn around it, and, by following in its bed, we succeeded in doing so too. From this point the walls on both sides are perpendicular. They are formed for the first few miles of conglomerate alone, which is horizontally stratified; it is, in fact, drift washed down by primeval floods from the mountain side. But as the gradual fall of the stream bed, which is on an average 50 feet per mile, brought us deeper into the earth, we reached the sandstones, and gradually passed through them to the hard granite beneath.

Luxuriant vegetation fills up the space between the walls; the undergrowth consists of willows, young trees, bunch grass, reeds, &c., forming in many places an impenetrable thicket, and above these a succession of noble trees tower up towards the sky, as if striving to rival the rocks on either side, and to gain a glimpse of the upper world. Under a grove of the loftiest cotton-woods and sycamores, at a distance of four miles from the head of the cañon, we threw down our blankets for the first night's rest. Not far distant a few deserted Indian wigwams were visible, perched upon the top of the cliff, which painfully reminded us of danger, and the setting sun beautifully illuminated three Norman watch-towers, which some freak of nature had carved out upon the precipice which rose above our grove of trees.

The obstacles which our surveyors had to contend against naturally made our progress very slow,—not more than from two and a half to three miles per day; for a clear path had to be cut through the brushwood which choked up the narrow passage, and every tree which obstructed the vision of the levellers had to be felled. Some Mexicans, who had lost their way and joined us a few days previously, were of great assistance to us; we hired six of their animals for pack-mules, and several of the men to help us as axemen, in cutting a path through the thickets. I obtained a mule for my photographic "outfit," and was thus enabled to take a number of views of the gorge. During the second day's advance we came to a cave hollowed out in the northern wall, capable of concealing about fifty men, and opposite this we picked up several Indian skulls and human bones. To these relics there hangs a tale:—

In 1863 a company of Californian volunteers, on their way eastward to fight the "rebs," and glad enough to get a little professional practice *en route*, joined in an expedition headed by a Captain Tidball, the object of which was to break up the chief rancheré of the Aravaypa Apaches, which was situated on this spot. The citizens and soldiers, guided by some tamed Apaches, who were kept at Camp Grant, entered, as we did, the head of the cañon, and came upon the Indian village just as the evening was changing to night. They hid quietly until daybreak, and then attacked the savages with such effect that out of seventy who formed the band but twelve escaped; all the rest were massacred, the women and children by the tamed Apaches, the warriors by the Americans. The fate of this band was not undeserved, for they had been the terror of the country round for a long time previously, and had committed many frightful atrocities upon the helpless Mexican and American settlers. These Apaches had carried on agriculture to some extent in the cañon, for we passed the remains of a few small irrigating canals in places where the space between the walls left a sufficient extent of bottom-land for such a purpose.

As we advanced, the cañon became more and more tortuous; bold walls of rock often enclosed us, in front and rear, as well as on either side; nor could we tell which way to turn until we had come close upon the apparently insurmountable barrier. Higher and higher towered the walls. For the first few miles they were flat and continuous from base to summit, although portions here and there stood out like huge needles or lofty spires from the main cliffs; but after attaining a certain height the walls became divided into two, the upper portion of which seemed to lean a little back, and to rise from the lower one, like a cliff springing from a cliff. The walls in fact became two stories high, and each story measured about 400 feet. The strata of the upper story or cliff continued as before to consist of conglomerate, but gray sandstone appeared at the base of the lower one, and gradually extended upwards. Caves and grottos became very numerous, and every mile added to the grandeur of the chasm.

The stream had to be crossed over and over again, often at every hundred yards, and it was curious to see how active the little axemen of nature—the beavers—had been, for many a wetting was saved, by our men on foot being able to cross over on the large trees, which, having been felled by these little fellows, had fallen athwart the stream. Nor were beavers the only inhabitants; deer came down to drink of the brook; but by what paths remained a mystery to us. Quails and doves were very abundant in places; birds with beautiful plumage, some bright red, others rich blue, and a third variety, a black and white kingfisher, with a bright-red crest, especially attracted our notice. I was photographing with a friend one afternoon in the cañon, about half a mile in the rear of the surveyors, when suddenly a succession of shots ahead made us start up from our work. The gloomy grandeur of such a place was not good for the nerves, and we feared terribly an Indian attack where the advantages of position were so much against us. Leaving the camera, black tent, and the rest, to take care of themselves, we hastened towards the front. A horse, minus his rider, dashed rapidly past, which did not increase our confidence; on arriving, however, at the scene of action we were not a little relieved on finding that a fine flock of turkeys had so tempted the foremost of our party, that, forgetful of the alarm they would cause, they seized their rifles and fired at them. The explosion caused by even a single shot in such a chasm sounded like the report of a dozen cannon, so great was the reverberation, and so many the echoes which followed it.

About 7½ miles from the entrance, the cañon becomes so narrow that it appears only as a cleft between the huge perpendicular walls which tower above us; there is no space whatever on either side between the bed of the stream and the rocks, so that the only passage is in the river itself. The action of the water, moreover, has hollowed out the base of the southern wall-rock for 20 or 30 feet of its thickness, so that you ride under the rock itself for some distance.

The first "narrows," as we called these passages, having been passed, we came to an open space of some 15 acres, giving us a good camping-ground and plenty of grass for the stock. This space is situated about the centre of the cañon, and is very beautiful, being filled with splendid timber, cotton-wood, sycamore, live oak, ash, willow, walnut, and grotesque old mesquits of most unusual size. Fine branches of mistletoe hung from many of the trees, and seemed to me like the familiar faces of dear friends suddenly encountered after a long separation. Just past this open space a great change takes place. In order, it would almost seem, that the traveller might not weary of the cold grey sandstone and conglomerate formations, the sombre tints and horizontal strata, large quantities of volcanic rock, with their smooth facets and rich tints, varying from purple and red to black, burst into view, and alter completely the appearance of the walls. A deep rich fringe of basaltic columns caps the terraces on either side, and this lava-form coating is bright and shining, the edges are as sharp in outline as if cut with a knife, and produce fantastic forms in the shape of turrets, &c., quite different in appearance from those met with previously.

Nor is the change to be seen only in the rocks; the vegetation immediately shows the difference of soil; and, identical in position with the new strata, there appeared for the first time on our route, the *Cereus giganteus*, the largest Cactus with which botanists are acquainted. Here these huge grooved columns thrust their thick trunks from between the crags and rise up on all sides far above our heads, to heights varying from the baby plant to forty feet. They seem to require no earth, and in places the walls are covered with them to the very summit, The secondary columns shoot out from the central stem and then turn upwards with studied regularity, forming a circle of four or six arms around the parent trunk. Besides the "monumental cactus," as it is sometimes called, large bushes of prickly pear, tufts of Spanish bayonet and Magay, with other kinds of spiny plants, also find a genial abode up amongst the crags, producing a contrast most singular and striking between the grotesque thorny vegetation upon the walls and the graceful foliage in the narrow passage beneath.

A little further, the rocks on either side approach so closely as to obliterate for a second time the entire passage, and the bed of the stream alone remains between the walls for two and a half miles of its course. At this part the walls present another break in their perpendicular height, and appear to consist of three terraces or cliffs piled one above the other, each capped, as before, with basaltic columns; thus showing, as it appears to me, the real nature of this terraced form. Each cliff or terrace is in fact a land-slip into the gorge, the lowest terrace representing the part earliest detached; for, as each terrace is covered with lava-form basalt, it is evident that at some time each ledge so covered must have formed part of the surface of the ground over which the lava had flowed.

Between the two narrows the cañon did not widen much; so that the lengthening shadows overtook us very early in the evening, and obliged the surveyors to cease from their work, And when the sun had left the upper world, and night had really come, the blackness of darkness around us was absolutely awful, and the stars which covered the long streak of sky above, seemed to change the heavens into a zigzag belt, every inch of which was radiant with diamonds.

Our camps too were very picturesque. The mesquit-tree, with its tortuous stems, grows to an unusual sizehere, and, as the wood makes magnificent fuel, we found the foot of one of them to be the best place to pass the night. Dotted about amongst the trees the cheerful blaze of a dozen fires would light up the branches and foliage, making the darkness visible, and giving us a glimpse now and then of the massive walls which towered up above us on all sides. We discovered an amusement for our long evenings, quite in harmony with the place.

Amongst the party of Mexicans, there was a tame Navajo Indian, who had been captured by his present master some years ago. This savage had many accomplishments, and amongst others, he knew the war songs and dances of several of the neighbouring tribes. He was very fond of our camp, for he seldom went away empty-handed; and when the fires were blazing up, and a good circle had been formed for him, he would come and sing his war songs until far into the night. A different dance accompanied each chant; the music was very wild and plaintive—a dreary dirge in a minor key; at particular parts it became very slow and piano, then a quick movement usually followed, the dance corresponding to the music, until the climax was reached by a series of yells which made the whole cañon re-echo with unearthly sounds. Our oft-repeated applause had the effect of exciting the little fellow to such an extent that he usually kept it up till he was thoroughly exhausted. So melancholy were the intonations of all these curious chants, that they seemed to be the fitting funeral marches of a people speedily and for ever passing away from their place among the races of the earth.

Three-fourths of the cañon was traversed and surveyed in four days. The remaining fourth, however, presented the most formidable obstructions; for large masses of wall-rock had fallen into the narrow cleft in so many places, that no sooner had we succeeded in getting our mules and horses over one pile of débris, than a fresh one lay across our path. We gradually entered, however, a more broken and open country, and gaps in the walls became proportionally frequent. Confusion seemed here to reign supreme; no longer did the abrupt walls hem us in, but large masses of rock—I may say sides of mountains—lay piled up all around. We measured one perpendicular cliff, which from its position was accessible to our instruments, and found it 825 feet high, and this was far below the average of the side-walls.

From out of this chaos the cañon gradually emerged, widening out, and approximating more to a narrow valley. The south side first begins to break away into sloping bluffs, covered with cactus and stunted vegetation, while the north side continues perpendicular for three miles and a half beyond the second "narrows," where it joins a huge mountain of igneous formation, consisting of six basaltic terraces, one above the other, and forming a fine landmark for miles around, to show the position of the cañon. Beyond this we have foot hills on both sides for two miles more, when the cañon becomes lost in a widening valley, which, some six miles further on, joins that of the Rio San Pedro, just south of Camp Grant. In this valley nearly all the water of the Aravaypa sinks into the earth. I hear, in fact, from residents at the fort that for many weeks during the year no surface water whatever enters the Rio San Pedro from it, although in the cañon there is always a fine stream.

An Indian trail, which is easily followed in single file, except where the bed of the stream alone is left, or where the whole pass is blocked up with débris, leads quite through the gorge. In the first half of the cañon there are at least five lateral means of exit through arroyos which enter it, one on the southern and four on the northern side, but there is no escape whatever for the rest of the way. Indian trails lead up these side-ravines. Some of our men in advance came one day across an Indian encampment in which the ashes of a fire were still smoking, but nowhere did we see an Indian. Their wigwams were of very frequent occurrence, during the last 8 or 10 miles, especially in the valley between the cañon and Camp Grant. They all consisted of a round frame-work of sticks, tied together with grass at the top, and lined within and without with willow, grass, and weeds, a little space being left for the door. It was evident, then, that we had frightened the Apaches out of their natural haunts. They feared, perhaps, another massacre, or they looked upon our instruments, which seemed to take up so much of our attention, as some infernal machines, intended to destroy them, had they given us a chance.

Be this as it may, we were glad enough to come aboveground again, for, apart from the oppressive feeling caused by such a place under any circumstances, the actual fact was always present in our minds that our enemy from above could, almost at any moment, have completely annihilated our whole party. Had the Indians thought proper to hurl rocks down upon us as we passed through many parts of the passage, from which there was no possible escape or hiding-place, not one of us could have escaped to tell the tale of this adventure.

On Wednesday, the 26th of November, 1867, I arrived at Camp Grant, and two days afterwards the whole party reached it safely. This post, consists, like all the others, of a collection of adobe houses, and log huts, with large covered verandahs to keep off the sun, for it is very hot here in summer. The view from it over the country is a very peculiar one, for, although not a tree is to be seen on the neighbouring hills, the *Cereus giganteus* takes their place. I have never seen it growing thickly, so as to hide a patch of ground from view; but everywhere these solitary pillars with their encircling arms are to be recognized, and as no other kind of vegetation is in the least conspicuous, they become the most prominent objects in the landscape.

The result of the survey from Railroad Pass to Camp Grant is the following:—

	Miles.	Feet above tide-water.
Summit of Railroad Pass	..	4411
Playa de los Pimas (centre of trough)	6·50	4275
Head of Aravaypa Cañada	22·52	4474
Eureka Spring	5·89	4164
Head of Aravaypa Cañon	19·41	3370
Leave high walled cañon	14·49	2645
Camp Grant	12·12	2174
Total in miles	81·93	

The Rio San Pedro enters the Rio Gila, 11·55 miles from Camp Grant, at an elevation of 1911 feet above the sea.

At the end of this paper will be found a table of distances and elevations determined by our surveyors whilst crossing the continent by the 32nd parallel, from Kansas City on the Missouri to the Pacific at San Francisco.

GENERAL FEATURES OF THE GREAT BASIN.

Between the Wahsatch Mountains and the Sierra Nevada, extending northward beyond the 42nd parallel, and southward into Lower California, lies a district, considerably larger than France, which goes by the name of the Great Basin. It has received the name simply from the fact that none of its rivers enter the sea. It is not an appropriate name, however, for it embodies a glaring topographical error.

The Colorado basin represents in shape a triangle, whose apex lies to the N. or N.E.; the Great Basin (we must retain the usual name), is also shaped like a triangle, whose apex points to the S. or S.W. From this apex at the Gulf of California, the ground rises from the level of tide-water, to about 5000 feet in Central Nevada, and this is about the general level of the whole country between the Sierra Nevada and the Wahsatch Mountains, in the broad part of the Great Basin. North of the Humboldt, where the drainage divides, this elevation is exceeded, and there are innumerable local depressions which scarcely reach 4000 feet, but north of the 37th parallel there are few places below this elevation.

There is great uniformity throughout the whole of the country; the surface is covered everywhere with short ranges of volcanic mountains of recent origin. Their general trend seems to be influenced mostly by their relative positions with respect to the great ranges on either side of them—the Sierra Nevada and the Wahsatch Mountains—for the tendency is to run parallel to whichever of these they are nearer, and in the centre of the basin the general direction is N. and S. In crossing the Great Basin from Donner Pass in the Sierra Nevada, to the Wahsatch range at Salt Lake, we passed over no fewer than twenty of these ranges, the basin at that latitude being 700 miles across. On the 35th parallel, nine ranges were crossed, on the 32nd a less number; as in the one case the distance was less than 300 miles, and in the other under 200 miles. The ranges consist chiefly of volcanic tufa, trachytic breccia, trachyte, and diversity of coloured porphyry, all more or less decomposed. They are mountains in miniature, beautiful in outline, variegated by many-tinted rocks, and usually perfectly bare of trees or even shrubs. They show on their sides the effect of rains and water to an enormous extent, for the volcanic rocks of which they consist are easily decomposed by the elements and then washed away. The ranges may, in former times, have been very long and continuous, but it is evident that, ever since their formation, water has been cutting them through, washing them down, and filling up the valleys with drift from their sides. The average width of the ranges would be about 12 miles, the height above the general level of the basin from 1000 to 4000 feet.

The valleys are mostly about 20 miles wide, and often of great length, but more frequently they are limited above and below by transverse ridges, which, however, are sometimes washed down to very inconsiderable dimensions, so as to form a number of separate little basins. The well-preserved water-marks which are everywhere visible, indicate extreme dryness, upon which dryness most of the peculiar characteristics of the country depend. Artemisia scrub (sedge-brush), and grease-wood,* alone spring from the dry, parched earth, except where some stream of unusual persistence supports a row of cotton-wood † trees, and a few acres of grass along its edges. From the decomposition of volcanic rocks, the soil in its ingredients is very fertile, and, where irrigation can be supplied, yields most abundant crops. There are broad level districts, however, called by the settlers "Alkali Flats," which are covered with salts, usually nitrate of soda, and are thereby rendered perfectly barren. These white glistening sheets in the dry unsteady atmosphere of the desert, form the most tantalising mirages to which a thirsty traveller could be exposed. At certain seasons they are covered for a short time with a thin coating of water—the local drainage of the surrounding district—which is soon dissipated by the scorching sun.

The plateau of the Basin region was undoubtedly the last part of the western continent raised from the sea—the last from which the Gulf of California retired. Even now subterranean fires are active, and the process of gradual upheaval may still be going on. Earthquakes are frequent, mud-volcanoes are still to be found in places, huge cracks in the earth's surface have occurred within the memory of living men, craters recently active dot the whole district, and hot-springs are so numerous that I have counted fifty-two jets of steam issuing from the ground, like pillars of smoke, in one valley alone.

When the "Great Basin" came into existence, or rather emerged from the waters, there were dry lands and mountains east, west, and north of it, shutting out from it the moisture of the Pacific Ocean, as well as any that might travel thither from the far-off Gulf of Mexico. The climate may be considered to have been then not unlike that of the present time, so that the rainfall was far less, even in the new-born "Basin region," than it was over the Colorado Basin in its primeval state, which was then washed by broad seas. The effect of these climatic peculiarities was that a sufficient quantity of rain never fell upon this Basin region, to form a complete system of drainage from the highest lands down to the sea.

We can easily conceive that in the formation of an extensive drainage system, the little primitive streams form lakes at the first serious obstacle met with in their course. These lakes, when full to overflowing, find at length some outlet, and wear the channel of exit deeper and deeper, until the obstacle is overcome, and the lake drained. Thus lake after lake is formed, and disappears as each succeeding obstruction is cut through, until the independent streams, having sought the lowest levels of the country, unite their waters into a single channel, and so pass into the sea. There is nothing whatever in the physical formation of the Great Basin to have prevented the formation of one great river, emptying into the Gulf of California, either as an independent stream or as as a tributary of the Rio Colorado. It is not because the "Great Basin" is really a complete basin without an outlet, or with a rim presenting an insurmountable barrier to the drainage, that its waters do not escape to the sea, but rather because it is not a single basin at all, but a collection of perhaps hundreds of basins, which have always remained in their primitive isolated condition, each with its stream and its lake at the end of it, and because the separate streams have never had force enough to break through the barriers which all streams have at first to encounter, and to unite their waters, so as to form a complete drainage-system. There is no doubt that formerly the atmosphere was more humid, and that more rain fell, for the remains of fresh-water shells of recent species, covering large tracts of desert, prove the existence of lakes much greater in extent than any which can now be found, but instead of being filled to overflowing, and breaking through their barriers to the sea, these lakes lost more water by evaporation and percolation than their tributary streams supplied, and thus were gradually dried up.

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* *Obione canescens.*

† *Populus angustifolia.*

The drainage, then, of the "Great Basin" is in a primitive stage, and will probably always remain so. Wherever there are lofty mountains, there we are pretty certain to find a lake proportionately great. If the lake has no outlet, it of necessity contains salt water, which becomes salter and salter as time advances, from the concentration, by means of evaporation, of the salts washed into it from the decomposed rocks of the mountains. But when the lake has an outlet, the water is, as usual, fresh. Great Salt Lake is an example of the former class; Utah Lake, in the same region, of the latter. Most of the lakes, however, are not permanent; they form broad sheets of water after rain, but are perfectly dry and barren during the greater part of the year. They vary greatly in elevation and size. Great Salt Lake exceeds 4000 feet above the sea-level;

Sevier, 5000; Lake Tahae, 6250; Monro Lake, 6454; Pyramid, 3940; Williamson's, 2388; Morongo Sink, 1500; Mojave Sink, 1000; and Perry Basin, 530.

Two depressions, at least, are below the level of the sea; the one is a large saline flat, situated a little north of the Mexican boundary line, which is usually called Soda Lake. It is about 70 feet below tide-water, and although nearly always perfectly dry, a long dyke, known as Hardy's Colorado or New River, flows through the desert towards it when the Great Colorado is flooded. Leaving the latter stream about half-way between Fort Yuma and its mouth, it receives the back-water of the Colorado, flows northward across the boundary line, and becomes lost in the desert before reaching Soda Lake. If it had sufficient volume this large depression would become filled with fresh water—a very desirable result.

The most wonderful depression, however, is Death Valley—the sink of the Amargoza—which is 175 feet below the sea. Although this depression is an arid desert, an enormous area of country drains into it, extending from lat. 37° to the San Bernardino Mountains, from which the Mojave River rises, and comprising not less than 30,000 square miles. At first sight it might appear that the existence of these depressions rather contradicted what I have said as to the causes which have produced the hydrographic peculiarities of this "Basin Region." But a glance at the Colorado Basin at once, I think, decides the question. Let us suppose that a humid climate had poured abundant rains upon the tableland, 1000 feet high, which separates Death Valley from the lowlands at the head of the gulf. A fine sheet of water would cover Death Valley, and this lake would have had an outlet to the sea through the opposing tableland. If 7000 feet of tableland yielded to the waters of the Rio Colorado, surely 1000 feet of similar formation would not prevent the overflow of a large lake from reaching the coast.

Great Salt Lake, the largest in the "Basin Region," is about sixty miles long, by ten broad,—a very small sheet of water, compared with the fresh-water lakes of the Eastern States, or those of Central Africa. But there is abundant evidence all around it to prove that in former times it covered an area twice, if not thrice, as great as it occupies at present. Of late years this lake has steadily been rising; so steadily, that if this rise continues, thousands of acres which are now lake-shore will soon be covered again with water. It is a question of considerable interest, whether the large tracts of land now irrigated by the Mormons have not caused this result, by considerably extending the area of evaporating surface, and increasing, as a consequence, the yearly rainfall.

The largest stream in the "Great Basin" is the Humboldt, which is more than 500 miles long, and passes from east to west across the entire district at its northern part before emptying into Humboldt Lake. The valley of this river is said to be generally so sandy as to be worthless, even if irrigated; but this conclusion may be premature, for many of the lands most productive when irrigated, look sandy and utterly worthless in their parched and wild condition. Much of the Rio Grande valley bears testimony to the truth of this assertion. Reese River fertilizes a narrow valley of about 100 miles in length, near the centre of the Basin, in which are several agricultural settlements. The same may be said of the Truckee, Carson River, Walker River, and some others, which flow from the eastern slopes of the Sierra Nevada into lakes in the desert. Along these, and the western slopes of the Wahsatch Mountains, a great many spots are favoured with enough running water to support a considerable population; and, in fact, all over the "Great Basin" the most tempting localities are being colonized and settled by little communities of Mormons from Salt Lake city, who are all agriculturists and nothing else. If, however, the Great Basin had only these attractions to hold out to emigrants it would be a region of as little interest as any on the globe; but amongst these barren monotonous ranges lie the vast deposits of silver ore, which, since the discovery of the Comstock lode, have been found to be scattered throughout the entire region. The lode just named has yielded, in the four years ending April 1st, 1866, 51,380,500 dollars, or upwards of 11,000,000*l.* sterling. Its present annual yield is about 600,000 lbs. avoirdupois of silver (containing more or less gold), worth about 4,000,000*l.* sterling,—a yield which exceeds the present yearly total of all the silver mines in Mexico. One Mining Company alone—the Sarage—last year (1867) paid in dividends a larger sum than that derived from all the metallic mines of England and Wales put together. Any day we may hear of another "Veta Madre" (as the Mexicans call one of these wide rich veins) being discovered; for by far the greater part of the Basin is as yet quite unknown, even to the indefatigable prospectors who brave all privations in the search for the precious metals. Mr. Ross Brown, in his last report on mining operations in the districts west of the Mississippi, gives the total yield of the gold-fields of California for the year that is passed at the small sum of 25,000,000 dollars, while that of Nevada is 20,000,000 dollars, of which the Comstock lode furnished about 14,500,000 dollars, thus leaving the large amount of over 5,000,000 dollars as the yield of the newly-discovered districts scattered throughout the Great Basin.

I may say, in conclusion, that there are many parts of the Colorado Basin still inviting exploration. There are, at least, three degrees of territory lying between the Mogollon Mountains on the west, and the Rio Grande del Norte on the East, quite unknown. Small bands of Apaches, however, prowl over this fertile upland country, and with these savages it is always war to the death.

West of this district lies another, drained by the Aqua Fria, Rios Verde, San Francisco, Salinas, and other northern branches of the Gila, flowing through fertile valleys shut in by lofty perpendicular sides—cañons often miles in width—and once thickly inhabited.

There is another vast region between the 39th and 36th parallels of latitude west of the Rocky Mountains, in which water is scarce, but hostile Indians are few—this is essentially a country of table-lands, the former is volcanic. The one contains, probably, no mineral wealth, the other is rich in the precious metals and minerals.

Then there is the 500 miles of cañon—the Great Cañon of the Colorado. If James White passed through it on a raft, surely at high water two parties might explore it thoroughly by entering one by Green River, the other by Grand River, in India-rubber boats built for the purpose.

Lastly, there is much of Sonora and Chihuahua unexplored. Through the former state I travelled for 700 miles. Both are well worthy of a visit, and, as the tropical rains reach them, the upland regions are fertile. The climate is unsurpassed throughout all these inland plateaux.

TABLE of DISTANCES and ELEVATIONS across the AMERICAN CONTINENT, from the MISSOURI RIVER to the PACIFIC OCEAN, about the 32nd parallel of latitude.

Elevations above Tide-water.	FROM KANSAS CITY (1318 miles from New York.)	Local Distances.	From Kansas City, *viâ*			
			Raton Mountain Route.	Puntia Pass Route.	Aubrey Route.	Cimarron Route.
Feet.		Miles.	Miles.	Miles.	Miles.	Miles.
Of low water of Bridge seat. 543	State Line, near Kansas City, to					
591	Lawrence	36	36	36	36	36
925	Fort Riley	99	135	135	135	135
1446	Fort Harker	83	218	218	218	218
1860	Fort Hays	71	289	289	289	
Grade 2957	Sheridan (end of track, 1868)	116	405	405		
3056	Fort Wallace	12	417	417		
3126	Pond Creek	3	420	420		
Surface of water *4056	Cheyenne Wells	40	460	460		
*4582	Denver Junction	10	470	470		
5180	Denver	160	630			
4192	Big Sandy	5	475	475		
	Colton's Spring	15	490	490		
Surface of water in Arkansas .. 3725	Fort Lyon	35	525	525		
4266	Mouth of Chequaco	50	575			
6166	Cimarron Pass (point of Raton Mountain)	40	615			
5634	Red River	64	679			
	Fort Union (near)	54	733		*698	*661
6233	Los Vegas	22	755		720	683
5406	Pecos River, near Anton Chico	26	781		746	709
6917	Cañon Blanco Pass (Summit of Spanish Range)	30	811		776	739
Surface of water 5042	Rio Grande, San Felipe	57	868	903	833	796
	Rio Grande, Albuquerque	60	871	933	836	799
Surface of water 4803	Rio Grande, Isletta	60	871	945	836	799
4803	Isletta (below Albuquerque)		871	945	836	799
4349	Fort Craig	102	973	1047	938	901
3896	Mouth of Santa Barbara Cañon	73	1046	1120	1011	974
4853	Summit West of Rio Grande	17	1063	1137	1028	991
4585	East foot of Cook's Mountain	14	1077	1151	1042	1005
4876	Summit of Cook's Mountain	3	1080	1154	1045	1008
4538	West foot of Cook's Mountain	4	1084	1158	1049	1012
4716	North end of Sierra Redondo	6	1090	1164	1058	1018
4472	Arroyo Miembres	9	1099	1173	1064	1027
4849	Ojo de la Vaca	12	1111	1185	1076	1039
4944	Summit at end of Burro Mountain	8	1119	1193	1084	1047
3992	Barney Station	22	1141	1215	1106	1069
3955	East foot of Peloncillo Mountain	21	1162	1236	1127	1090
4148	Summit Runk's Pass	4	1166	1240	1131	1094
3438	West foot of Peloncillo Mountain	12	1178	1252	1143	1106

* Barometer elevations.

TABLE OF DISTANCES AND ELEVATIONS—*Continued.*

Elevations above Tide-water.	FROM KANSAS CITY (1318 miles from New York.)	Local Distances.	From Kansas City, *viâ*			
			Ratcn Mountain Route.	Puntia Pass Route.	Aubrey Route.	Cimarron Route.
Feet.		Miles.	Miles.	Miles.	Miles.	Miles.
3816	East foot of Railroad Pass (Chiricahui Mountains)	27	1205	1279	1170	1133
4192	Summit of Chiricahui Mountains	7	1212	1286	1177	1140
3998	West foot of Chiricahui Mountains	6	1218	1292	1183	1146
3985	East foot of Calitro Mountains	6	1224	1298	1189	1152
4522	Summit of Calitro Mountains	10	1234	1308	1199	1162
3256	Mouth of Nugent's Pass (Tres Alamos)	21	1255	1329	1220	1183
1985	Fort Grant	63	1318	1392	1283	1246
1692	Mouth of San Pedro	11½	1330	1403	1294	1257
1594	Head of Cañon of Gila	9	1339	1412	1303	1266
1202	White's Ranche	44	1383	1456	1347	1310
1066	Saccaton	15½	1398	1472	1363	1326
	Pima Villages	11	1409	1483	1374	1337
	Maricopa Wells	12	1421	1495	1386	1349
*108	Fort Yuma (75 feet above the river)	167	1588	1662	1553	1516
*1101	East foot of San Gorgonia Pass	154	1742	1816	1707	1670
*2808	Summit of San Gorgonia Pass	22	1764	1838	1729	1692
1118	West foot of San Gorgonia Pass	24	1788	1862	1753	1716
*1118	San Bernardino	2	1780	1864	1755	1718
*1048	San Fernando Mission	75	1865	1939	1830	1793
*3164	Summit of Soledad Pass	43	1908	1982	1873	1836
2889	Desert	8	1916	1990	1881	1844
	Willow Springs	34	1950	2024	1915	1878
*3080	East foot of Tehachapa Pass	17	1967	2041	1932	1895
4008	Summit of Tehachapa Pass	15	1982	2056	1947	1910
795	West foot of Tehachapa Pass	35	2017	2091	1982	1945
	Gilroy	210	2227	2301	2192	2155
Tide-water	San Francisco	80	2307	2381	2272	2235
	This distance from Kansas City to San Francisco may be reduced, by estimated saving, between Fort Craig and Saccaton, of 75 miles, to		2232	2306	2197	2160
	New York to San Francisco (measured)		3625	3699	3590	3553
	Ditto (shortest)		3550	3624	3515	3478

* Barometer elevations.